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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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Federal Communications Commission
Office of Secretary

In the Matter of	)	
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	)	
The Development of Operational,	)	WT Docket No. 96-86
Technical, and Spectrum	)	
Requirements for Meeting	)	
Federal, State and Local Public	)	
Safety Agency Communication	)	DOCKET FILE COPY ORIGINAL
Requirements Through the	)	
Year 2010	)	

To: The Commission

COMMENTS OF QUANTUM RADIONICS CORPORATION

QUANTUM RADIONICS CORPORATION

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21 October 1996

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RESPECTFULLY SUBMITTED,

QUANTUM RADIONICS CORPORATION

Judith Fay Furie
President and
Chief Executive Officer

Dr. Gregory M. Stone
Executive Vice President and
Chief Operating Officer

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21 October 1996

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COMMENTOR'S QUALIFICATIONS

Quantum Radionics Corporation, hereinafter referred to as QRC, is a high technology engineering research and development firm providing scientific, engineering, technical, and professional support to government and industry. The Executive Vice President and Chief Operating Officer of QRC is Dr. Gregory M. Stone. Dr. Stone holds a Ph.D. in Electrical Engineering, is a member of the Association of Public Safety Communications Officials International (APCO), the Institute of Electrical and Electronics Engineers (IEEE), and, is a Fellow in the Radio Club of America (RCofA).

Dr. Stone has in excess of sixteen years progressive experience in the areas of law enforcement and public safety wireless communications system research, development, and engineering. Current areas of involvement include: 3-dimensional electromagnetic wave propagation modeling and simulation; development of unified wireless communication simulation, modeling, and design methodology applicable to high speed digital wireless systems employing m-ary modulation; linear wireless system architectures; and, cryptographically protected wireless communications systems. He also is engaged in the development and application of advanced electronic crime countermeasure technologies. Dr. Stone has served as a consultant to numerous Federal, state, and local law enforcement, public safety, and governmental agencies, and to such commercial clientele as: IBM; Ameritech; NYNEX; and, GTE.

Dr. Stone currently serves as Chairman of the IEEE VTS-Propagation Committee; as Co-Chairman Telecommunications Industries Association TR-8, WG8.8 Technology Compatibility Committee; and, as a Member of the Executive Committee, IEEE International Carnahan Conference on Security Technology.

All comments contained in this filing are solely those of QRC and do not necessarily represent the opinions or position of any other entity.

EXECUTIVE SUMMARY

In response to the Commission's Notice of Proposed Rulemaking, WT Docket 96-86, QRC presents its position on matters relating to several of these areas for consideration by the Commission.

QRC views the wireless interoperability solution in the public safety community twofold: firstly, through the adoption of a set of standards such as Project 25, that provides for common protocols, data rates, and air interface. QRC views Project 25 and similar efforts as essential elements in achieving widespread interoperability between and amongst public safety providers. Furthermore, QRC views standards such as Project 25 as stimulating competition and technological innovation in a traditionally conservative community.

Secondly, QRC recommends allocating additional spectrum contiguous to the current public safety VHF High Band, now occupied by VHF television in the band 174-216 MHz as previously suggested by the NTIA. QRC does not represent, however, that the 42 MHz of spectrum available in the 174-216 MHz band is sufficient to satisfy public safety demand.

QRC supports the Public Safety Wireless Advisory Committee (PSWAC) analysis, which provides in detail the significant public safety spectrum requirements. The allocation of the aforementioned 42 MHz will promote interoperability, and allow public safety to deploy more cost-effective systems, and, to this end, the Commission should first allocate this 42 MHz of spectrum to public safety. In addition, the 300-406 MHz spectrum should be allocated to public safety to satisfy additional requirements as articulated in the PSWAC document.

QRC supports the findings of the PSWAC that concluded additional spectrum is by far the greatest need held by the public safety community. QRC performed comprehensive engineering simulation and modeling of frequency loss at 160, 406, 850, and 1500 MHz. The simulation and modeling methodology employed was based upon the recommendations contained in the Telecommunications Industries Association TR-8, Working Group 8.8, Technology Compatibility Committee, "A Report on Technology Independent Methodology for the Modeling, Simulation and Empirical Verification of Wireless Communications System Performance in Noise and Interference Limited Systems Operating on Frequencies Between 30 and 1500 MHz," dated 29 April 1996, version WG8_8_16.doc.

Based upon QRC's extensive theoretical study and analysis of the practically relevant simulations, QRC concludes that the interests of public safety are best served by contiguous spectrum allocations in the VHF High Band between approximately 174 and 216 MHz to minimize infrastructure cost to the public safety community, while providing for the most effective and optimal wireless communications system performance.

QRC advocates that the Commission provide the regulatory flexibility to encourage the development of Advanced Multimode Digital Communications (AMDC) wireless architectures that permit the wholesale overlay of any spectrum on a non-interference basis. AMDC systems can satisfy not only the covert communications requirements of public safety that cannot be adequately satisfied by non-wideband techniques, but can also serve as a capacity buffer to satisfy especially voracious spectrum needs. Therefore, AMDC would essentially serve to add capacity in the period beyond the 2010 date that is the subject of this NPRM without additional dedicated or refarmed spectrum allocations.

With regards to the Commission's request for performance requirements for public safety equipment and systems needed to ensure efficient and effective support to public safety operations, QRC recommends that the Telecommunications Industries Association TR-8, Working Group 8.8, Technology Compatibility Committee, "A Report on Technology Independent Methodology for the Modeling, Simulation and Empirical Verification of Wireless Communications System Performance in Noise and Interference Limited Systems Operating on Frequencies Between 30 and 1500 MHz," dated 29 April 1996, version WG8_8_16.doc, serve as the standard for public safety wireless system modeling, simulation, design, empirical performance validation, and for spectrum management purposes.

The Commission's NPRM makes numerous declarative statements concerning the efficacy and alleged benefits of trunking technology that are not correct unless certain very limited factual assumptions are in effect. Trunked systems never can achieve the capacity, per channel or per trunk, as a non-trunked channel, due to trunking control overhead. While a properly designed trunked system does provide automatic balancing or leveling of user load, this can also be accomplished for far less cost by properly designing, sizing, and implementing a conventional non-trunked system.

QRC recommends the Commission adopt the document, "Public Safety Wireless Communications User-Traffic Profiles and Grade-Of-Service Recommendations", dated 13 March 1996, developed by QRC, as the baseline authority for public safety loading and grade-of-service. This document, adopted by PSWAC, ensures that sound traffic engineering principles are applied in the design of either a conventional or trunked public safety wireless system.

QRC believes the following are spectrally efficient candidates for digital voice and data transport: (1) multi-carrier/multitone linear modulation in an FDMA or TDMA architecture; and (2) single carrier linear modulation in an FDMA or TDMA architecture.

QRC recommends that a concept of Voice Channel Equivalent Erlangs be adopted, whereby the offered load of any type of service (i.e., data, video) have its load normalized to a Voice Channel Equivalent. Thus, spectrum efficiency may be measured by a technology's ability to convey the most Voice Channel Equivalent Erlangs per MHz bandwidth per square kilometer. This approach normalizes load to a Voice Channel Equivalent baseline.

INTRODUCTION

The Commission is seeking comments on a number of areas concerning public safety communications including:

1. Regulatory approaches that will facilitate the development of interoperable equipment and technologies;

2. The service features and system requirements essential to the effective performance of public safety functions;

3. Technological issues regarding the enhancement and improvement of public safety wireless communications;

4. Means of allocating spectrum for public safety agencies to ensure that they have adequate spectrum to perform their duties;

5. The measures that need to be implemented in order to foster an environment that promotes public safety wireless communications, which are spectrally-efficient, of high quality, and effective; and

6. The means to promote competition in the supply of goods and services used by public safety agencies.

QRC will present its position on matters relating to several of these areas for consideration by the Commission in its formulative process.

SPECIFIC COMMENTS

Public Safety Wireless Communications Interoperability Options (reference item 32, Page 13 and 14)

QRC views the wireless interoperability solution in the public safety community twofold:

> Firstly, through the adoption of a set of <u>standards</u> such as Project 25, that provides for common protocols, data rates, and air interface; and,
>
> Secondly, through allocating <u>additional spectrum contiguous</u> to the current public safety VHF High Band, now occupied by VHF television in the band 174-216 MHz as previously suggested by the NTIA.

Role of Wireless Communications Standards in Public Safety Wireless Interoperability
(reference items 41 and 42, Page 16)

QRC has supported and participated in the APCO/NASTD/FED Project 25 standard process for several years. QRC views Project 25 and similar efforts as essential elements in achieving widespread interoperability between and amongst public safety providers. Furthermore, QRC views standards such as Project 25 as stimulating competition and technological innovation in a traditionally conservative community.

Additional Contiguous Spectrum and Frequency Band Selection
(reference item 34 Page 14):

QRC supports the findings of the Public Safety Wireless Advisory Committee that concluded additional spectrum is by far the greatest need held by the public safety community.

The fundamental issues revolve around which frequency band is optimal for public safety use and thus, where the Commission is best recommended to concentrate on directing its efforts.

It is well known that wireless system coverage is highly dependent upon frequency (wavelength) of operation. Frequency dependent losses are largely due to the dispersion of the wavefront at the shorter wavelengths (higher frequencies). In simplest terms this loss is a function of 20 log f, where f is the frequency in megahertz. Thus, there is a quantifiable power impact on the use of higher frequencies, say as compared to a 150 MHz baseline. Assuming the frequency dependent loss increases at 20 log f, the relative difference from 150 MHz to 1800 MHz may be seen in the following table:

FREQUENCY DEPENDENT LOSS
(20 log f)

Frequency in MHz	20 log f Loss in dB	Change in dB (ref. 150 MHz)
150	43	0
300	49	6
450	53	10
900	59	16
1800	65	22

The final column that depicts the "change" in dB represents the effective theoretical power penalty associated with increasing frequency as referenced to 150 MHz. This may be viewed in terms of a "power impact".

To put this power impact into better perspective, let us consider the following table:

POWER IMPACT
(ref. 150 MHz @ 100 W Effective Dipole Radiated Power)

Frequency in MHz	EdRP Required
150	100 Watts
450	1,000 Watts
900	4,000 Watts
1,800	15,850 Watts

While QRC found this analysis most disturbing, it does help to explain why spectrum shortages in the VHF High Band (150-174 MHz) and UHF (406-512 MHz) bands have driven many public safety entities to move to 800/900 MHz and beyond.

The forced migration of public safety systems to the 800/900 MHz or 1500 MHz bands necessitates building systems several times more complex (and costly) than was traditionally the case in the VHF high band (150-174 MHz) and UHF (406-512 MHz) spectrum.

Notwithstanding this theoretical analysis of the adverse impact of using higher frequencies for public safety, QRC found a need to address the practical implications of frequency band selection that considers a multitude of factors commonly addressed in public safety system design.

Furthermore, QRC believed it was essential to base the simulation effort upon predicates that were reasonable and typical of public safety systems, and moreover, to employ a simulation methodology based upon the standards efforts resulting from work of the joint Telecommunications Industries Association (TIA) TR-8, Technology Compatibility Working Group 8.8 and Institute of Electrical and Electronic Engineers (IEEE) Vehicular Technology Society Propagation Committee.

The engineering simulation and modeling methodology QRC employed was based upon the recommendations contained in the Telecommunications Industries Association TR-8, Working Group 8.8, Technology Compatibility Committee document entitled:

"A REPORT ON TECHNOLOGY INDEPENDENT METHODOLOGY FOR THE MODELING, SIMULATION AND EMPIRICAL VERIFICATION OF WIRELESS COMMUNICATIONS SYSTEM PERFORMANCE IN NOISE AND INTERFERENCE LIMITED SYSTEMS OPERATING ON FREQUENCIES BETWEEN 30 AND 1500 MHz"

dated 29 April 1996, version WG8_8_16.doc.

(Note: In respecting TIA policy, until finalized, this document is publicly releasable only by the TIA. Interested parties should contact Mr. Wayne Leland at Motorola, Inc. for copies of this document or its successor version.)

In so doing, QRC conducted detailed computer simulations based upon the following predicates:

- Use of Current Generation Advanced Narrowband Digital Technology;
- Public Safety Quality Service with a Delivered Audio Quality of 3.4 (DAQ is the acronym for Delivered Audio Quality which is used as the qualitative expression of audio in both analog and digital systems in the referenced TIA/IEEE document);
- Use of the Okumura/Hata/Davidson Empirical Electro-Magnetic Wave Propagation Model in conjunction with the Epstein/Peterson Diffraction Model (consistent with the TIA/IEEE document);
- Repeater Operation in a Vehicular/Mobile Radio Environment Assuming Talk-Out (talk-in can be addressed by means of a satellite receiver/voting comparator network);
- Effective Dipole Radiated Power levels consistent with good engineering practice;
- Hypothetical Operation in New York City, New York based upon the use of the World Trade Center as the Talk-Out Site;
- Hypothetical Operation in Los Angeles, California, based upon the use of Mount Lukens as the Talk-Out Site; and
- Hypothetical Operations Simulated at 160, 406, 850, and 1500 MHz in both New York City and Los Angeles to provide for Quantitative Analysis of Frequency Band Performance.

Specific parametric assumptions used in the simulations included:

- Public Safety Coverage Standard of 97% Area;
- 30 Meter Terrain Resolution with Land Use Land Clutter;
- Public Safety Coverage Margin of 11.5 dB;
- Faded Detection System Sensitivity of -108 dBm for DAQ 3.4;
- Unfaded Detection System Sensitivity of -118 dBm for DAQ 3.4; and
- Application of the appropriate ambient radio frequency noise recommendations consistent with the WG8.8 document.

The simulation runs for 160, 406, 850, and 1500 MHz are presented in graphic form for New York City and Los Angeles in Exhibit-1 through Exhibit-8 attached to this filing. The area in white represents the coverage predicted by the simulations for moving vehicles at a faded detection sensitivity of -108 dBm. The area in yellow represents the increase in coverage predicted by the simulation when the vehicle is stationary at a unfaded sensitivity of -118 dBm.

Using the results of the 150 MHz simulation as the baseline, QRC performed a comparative analysis of the coverage projected at 406, 850, and 1500 MHz.

The results of this comparative analysis are presented in the following table:

PERCENTAGE COVERAGE RELATIVE TO 160 MHz

	Los Angeles	New York City
160 MHz	100 %	100%
406 MHz	70%	68%
850 MHz	40%	55%
1500 MHz	32%	41%

From both our theoretical study and analysis of the practically relevant simulations, QRC concludes that the interests of public safety are best served by contiguous spectrum allocations in the VHF High Band between approximately 174 and 216 MHz to minimize infrastructure cost to the public safety community, while providing for the most effective and optimal wireless communications system performance.

QRC does not represent, however, that the 42 MHz of spectrum available in the 174-216 MHz band is sufficient to satisfy public safety demand.

QRC supports the Public Safety Wireless Advisory Committee (PSWAC) analysis, which provides in detail the significant public safety spectrum requirements. The allocation of the aforementioned 42 MHz will promote interoperability, and allow public safety to deploy more cost-effective systems, and, to this end, the Commission should first allocate this 42 MHz of spectrum to public safety. In addition, the 300-406 MHz spectrum should be allocated to public safety to satisfy additional requirements as articulated in the PSWAC document.

Public Safety Wireless Service Features
(reference item 48, Page 18 and item 49, Page 19)

QRC believes that current Frequency Division Multiple Access, Time Division Multiple Access, and Code Division Multiple Access architectures provide adequate potential to address public safety needs between 1996 and approximately 2005. However, by 2005 additional technological innovation is clearly required.

In response to the Commission's request for specific public safety wireless service features and requirements, QRC offers the following as basic requirements for public safety wireless systems:

Support Teleservices:

- Enciphered and unenciphered digital speech
- Individual call (point-to-point)
- Group Call (point-to-multipoint)
- Broadcast Call (point-to-multipoint one way)

Support Bearer Services:

*Enciphered and unenciphered digital data

- Circuit switched unreliable data
- Circuit switched reliable data

- Packet switched unconfirmed delivery data
- Packet switched confirmed delivery data
- Circuit switched data network access
- Packet switched data network access
- Preprogrammed data messages

Support Video Services:

- Enciphered and unenciphered slow motion video
- Enciphered and unenciphered full motion video
- Individual call (point-to-point)
- Group call (point-to-multipoint)
- Broadcast call (point-to-multipoint one-way)

Support Supplementary Services:

- End-to-end encipherment
- Over-the-air cryptographic rekey
- Over-the-air-control
- Priority call
- Pre-emptive priority call
- Call interrupt
- Voice telephone interconnect
- Discrete listening
- Ambiance listening

- Talking party identification

- Call alerting

However, QRC also believes that the Commission should proactively address likely requirements post 2010.

QRC advocates that the Commission provide the regulatory flexibility to encourage the development of Advanced Multimode Digital Communications (AMDC) wireless architectures that permit the wholesale overlay of any spectrum on a non-interference basis. Thus, AMDC systems can satisfy not only the covert communications requirements of public safety that cannot be adequately satisfied by non-wideband techniques, but can also serve as a capacity buffer to satisfy especially voracious spectrum needs.

QRC sees the Advanced Multimode Digital Communications concept embodying the following attributes:

- An AMDC architecture would provide for significantly improved spectral efficiency by means of very wide band overlay of existing narrowband and wideband services on a non-interference basis. This overlay approach would support the operational usage of hundreds of operational users per given geographic area;

- An AMDC architecture would afford Low Probability of Intercept, Low Probability of Detection, and Low Probability of Exploitation (LPI/LPD/LPE);

- An AMDC architecture would support infrastructure independent multipoint communications operations;

- Integrated Embedded COMSEC and TRANSEC would be included;

- Adaptive variable bandwidth and information transmission rate capability would be provided to suit any operational scenario;

- Adaptive power control would be used, if required, along with adaptive detection system techniques and adaptive modulation, coding, and spread factors to both reduce energy densities and to improve LPD/LPI;

- Link and end-to-end COMSEC with Multikey, Over-the-Air-Rekey (OTAR), and Over-the-Air-Control (OTAC);

- Fixed, mobile (vehicular), and portable/handheld elements of variable size, configuration, and transportability;

- Advanced, lightweight, long life secondary power sources (storage batteries) that provide for significant improvement over the current life and energy capability of either nickel metal hydride, lithium, or nickel cadmium technologies;

- Fully exploit broadband radio frequency circuit and antenna technologies to permit the efficient transmission and reception over multiple frequency bands needed to support very wide spread factors, i.e., 100's of MHz;

- Utilize broadband antenna technologies that replicate and accommodate current vehicular AM and FM broadcast antennas in a vehicular/mobile environment;

- Support transport rate intensive multimedia digital information transmission including, but not limited to: compressed full motion full color video; telephoto transmission including mugshots and other forms of imagery; fingerprints, both as images and as data files; large (30k), medium (10k) and small (2.5k) binary file transfer;

- Scaleable systems that support both simplex (infrastructure independent unit-to-unit party line, i.e., multipoint) and repeater (infrastructure dependent) operation. Repeater operation must be scaleable to include both single site standalone low density systems through complex multi-site systems incorporating simulcasting and satellite receiver voting or comparable technologies;

- Integrates the use of GPS or its successor systems for the purposes of position location monitoring and to facilitate the automatic control of mobile and portable radio frequency selection to minimize operator intervention when traveling through multiple communications systems or elements;

- Employs biometric user/operator authentication for radio and cryptographic subsystems; and

- Permits access to emerging mobile satellite and competing terrestrial wireless communications modalities (Thus a single subscriber set could operate in various narrowband modes, provide access to commercial carriers, and operate in the AMDC wideband mode.

Over the long term, i.e., beginning sometime after 2000 but before 2010, deployment of an AMDC architecture is predicated upon the wholesale overlay of vast amounts of existing spectrum. Thus, AMDC would essentially serve to add capacity in the period beyond the 2010 date that is the subject of this NPRM without additional dedicated or refarmed spectrum allocations.

Public Safety Wireless System Requirements
(reference item 51, Page 19)

The Commission specifically requested comments appertaining to the performance requirements for public safety equipment and systems needed to ensure efficient and effective support to public safety operations.

Previously QRC referenced a work prepared by the Telecommunications Industries Association TR.-8, Working Group 8.8, Technology Compatibility Committee, and the IEEE VTS Propagation Committee, embodying a comprehensive engineering, simulation, and modeling methodology.

QRC asserts the TIA/IEEE VTS document titled:

"A REPORT ON TECHNOLOGY INDEPENDENT METHODOLOGY FOR THE MODELING, SIMULATION AND EMPIRICAL VERIFICATION OF WIRELESS COMMUNICATIONS SYSTEM PERFORMANCE IN NOISE AND INTERFERENCE LIMITED SYSTEMS OPERATING ON FREQUENCIES BETWEEN 30 AND 1500 MHz"

dated 29 April 1996, or its successor version, should serve as the standard for public safety wireless system modeling, simulation, design, empirical performance validation, and for spectrum management purposes.

(Note: In respecting TIA policy, until finalized, this document is publicly releasable only by the TIA. Interested parties should contact Mr. Wayne Leland at Motorola, Inc. for copies of this document.)

It is noteworthy that similar conclusions were reached by the Public Safety Wireless Advisory Committee and its sub-committees, who universally endorsed this TIA/IEEE work.

Public Safety Wireless Technology Issues
(item 57 Page 21)

The Commission's NPRM makes numerous declarative statements concerning the efficacy and alleged benefits of trunking technology that are not correct unless certain very limited factual assumptions are in effect.

The Commission asserts, for example, that trunking technology permits hundreds of users to share a limited number of channels with out interference. This is not the case unless the hundreds of users served very rarely use their radio and, when and if they do, it is for very short periods of time. Furthermore, trunked systems never can achieve the capacity, per channel or per trunk, as a non-trunked channel.

In a conventional system each channel or trunk has a capacity of one (1) Erlang. In a trunked system each channel or trunk has a capacity of less than one (1) Erlang due to trunking control overhead.

What a properly designed trunked system does provide is an automatic balancing or leveling of user load, which can also be accomplished for far less cost by properly designing, sizing, and implementing a conventional non-trunked system.

This brings us to another key point, that is, sizing a system to support the appropriate offered load. QRC asserts that sound traffic engineering principles must be applied in the design of either a conventional or trunked public safety wireless system. In advocating such a position, QRC developed initially for APCO Project 25 and subsequently submitted to the PSWAC a document entitled: ***Public Safety Wireless Communications User-Traffic Profiles and Grade-Of-Service Recommendations***, dated 13 March 1996. This document is provided as Exhibit-9 to this filing.

The PSWAC, in its deliberations, adopted our traffic profile and grade-of-service recommendations contained in the subject report. QRC recommends the Commission now adopt this document as the baseline authority for public safety loading and grade-of-service.

Public Safety Candidate Spectrally Efficient Wireless Technology (reference item 58, Page 22)

Today in 1996, QRC believes the following are spectrally efficient candidates for digital voice and data transport:

1. Multi-carrier/multitone linear modulation in an FDMA or TDMA architecture

2. Single carrier linear modulation in an FDMA or TDMA architecture

Attached as Exhibit-10 to this filing is material addressing Advanced Digital Wireless Technologies, which is provided for the Commission's consideration. This material was originally presented to the PSWAC on 1 March 1996.

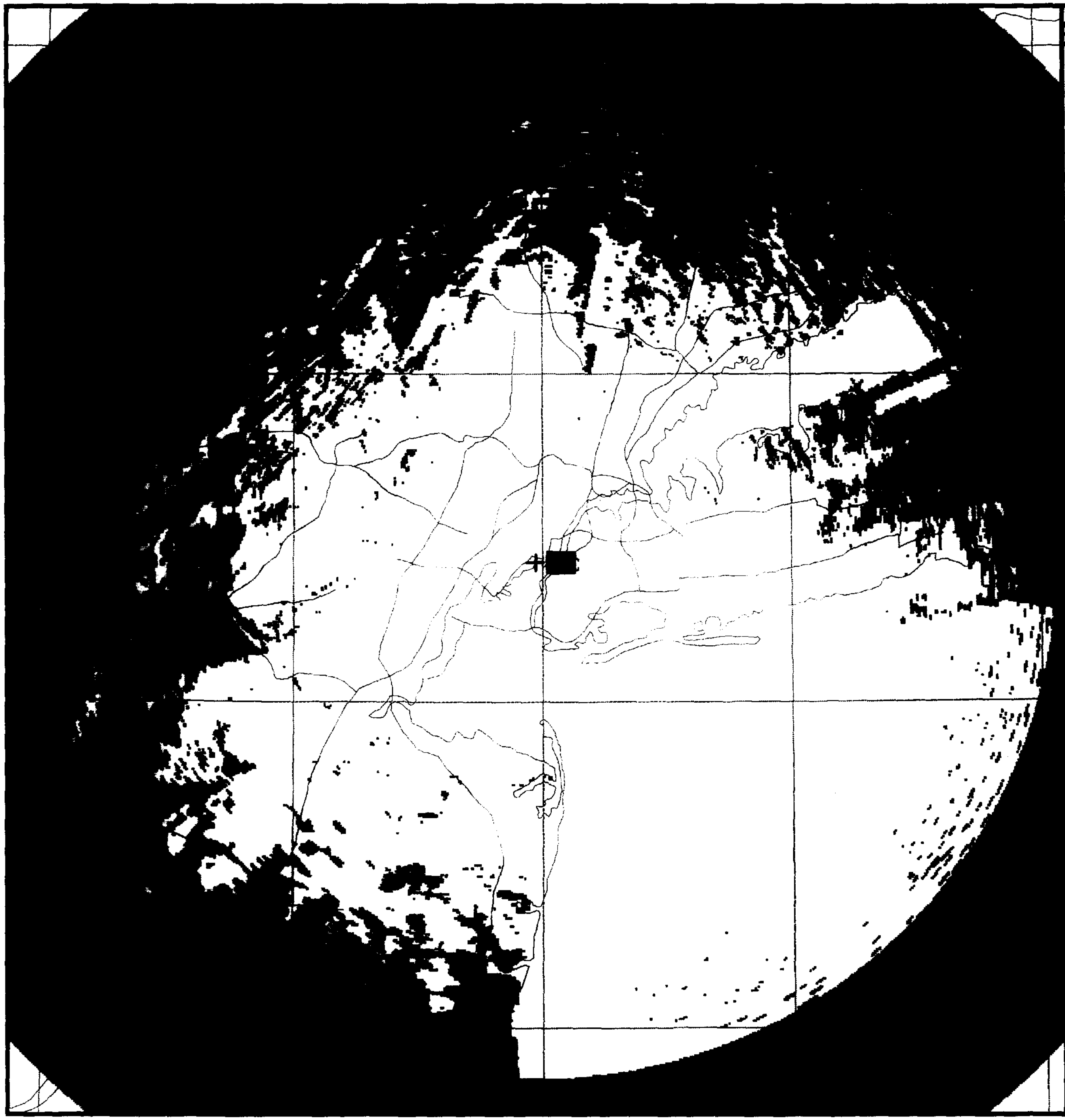
In addition, QRC asserts that the Commission adopt a very straightforward yet pragmatic approach to determining the spectrum efficiency of disparate technologies and in the establishment of spectrum efficiency requirements.

QRC recommends that a concept of Voice Channel Equivalent Erlangs be adopted, whereby the offered load of any type of service (i.e., data, video) have its load normalized to a Voice Channel Equivalent.

Thus, spectrum efficiency may be measured by a technology's ability to convey the most Voice Channel Equivalent Erlangs per MHz bandwidth per square kilometer. This concept is presented in the following expression:

$$E_{vce}/MHz/Km^2$$

It is important to note that this measure of spectrum efficiency is similar to that proposed by Hatfield and MacDonald, but the QRC approach normalizes load to a Voice Channel Equivalent baseline.



SIGNAL (tm):

Propagation model: Hata-extended/E-P diff
Time: 99.00% Loc: 97.00% Margin: 11.5 dB
Climate: Continental Temperate
Gndcvr: USGS-EDX database
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 3.3 feet AGL Gain: .0 dBd

Received power (at remote)

> -108.0 dBmW
-118.0 to -108.0 dBmW
< -118.0 dBmW

Minimum threshold level: -150.0 dBmW

Site	Ant Elv AMSL (feet)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
WTC *	1359.8	20.00	OM-V	N 40 42 43.00
grp: 2	160.0000 MHz			W 74 0 49.00

MILES
10 0 10 20 30

NYC SIMULATION

VHF HIGH BAND 160 MHz

17 September 1996 MO Talk-Out

EXHIBIT-1

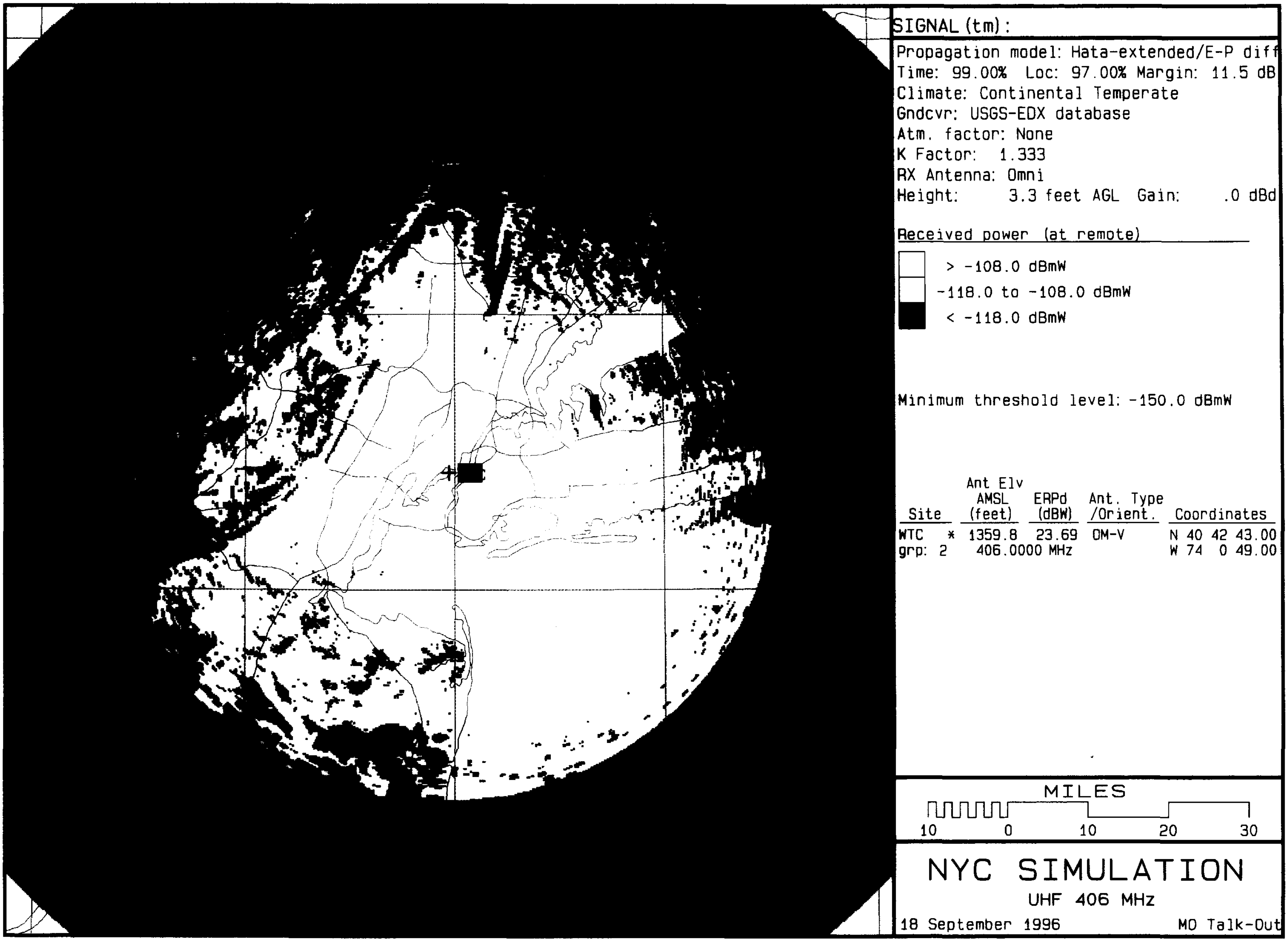
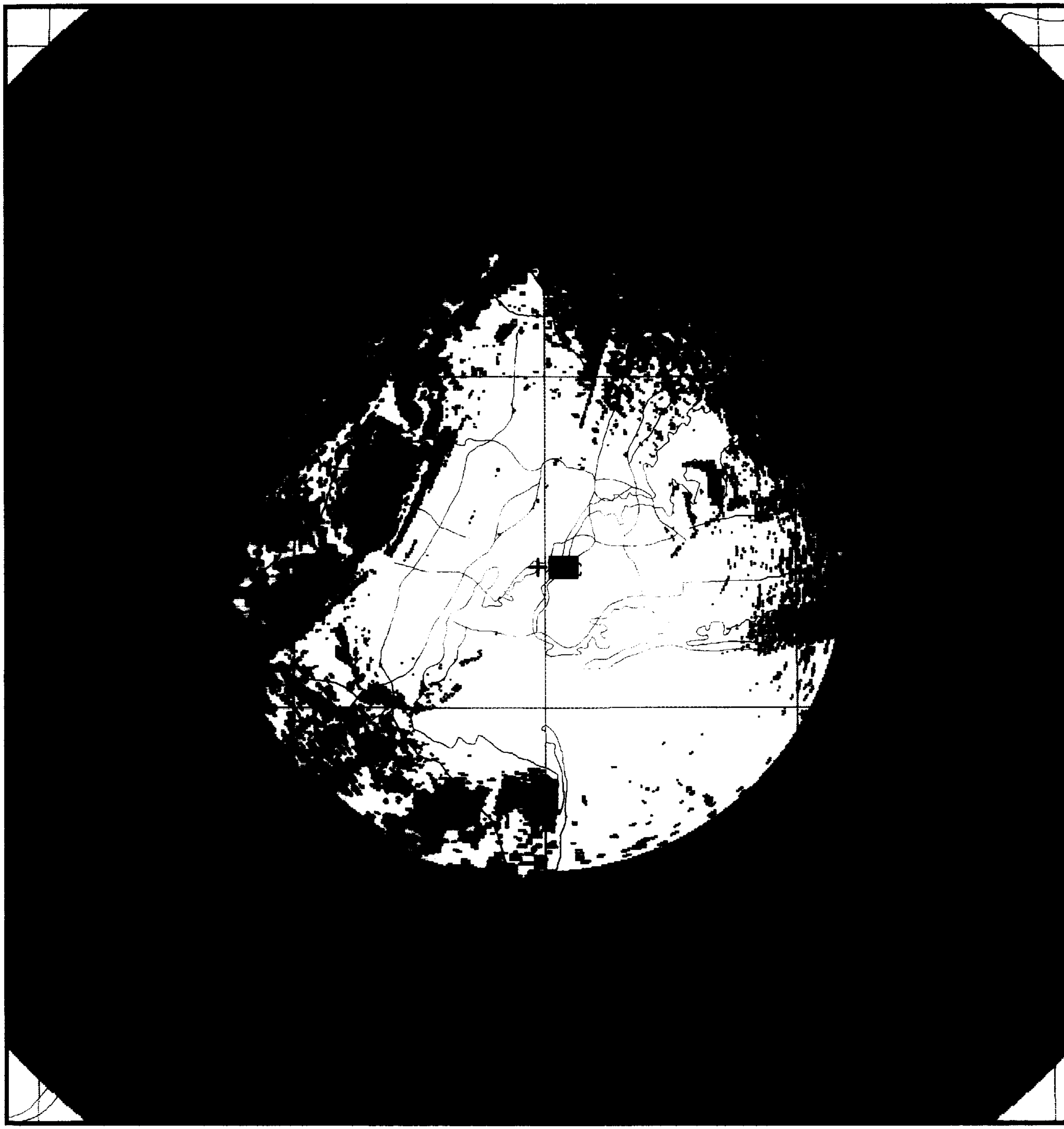

SIGNAL (tm):
Propagation model: Hata-extended/E-P diff
Time: 99.00% Loc: 97.00% Margin: 11.5 dB
Climate: Continental Temperate
Gndcvr: USGS-EDX database
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 3.3 feet AGL Gain: .0 dBd
Received power (at remote)
> -108.0 dBmW
-118.0 to -108.0 dBmW
< -118.0 dBmW
Minimum threshold level: -150.0 dBmW
Site | Ant Elv AMSL (feet) | ERPd (dBW) | Ant. Type /Orient. | Coordinates
WTC * | 1359.8 | 23.69 | OM-V | N 40 42 43.00
grp: 2 | 406.0000 MHz | | | W 74 0 49.00
MILES
10 0 10 20 30
NYC SIMULATION
UHF 406 MHz
18 September 1996
MO Talk-Out

EXHIBIT-2



SIGNAL (tm):

Propagation model: Hata-extended/E-P diff
Time: 99.00% Loc: 97.00% Margin: 11.5 dB
Climate: Continental Temperate
Gndcvr: USGS-EDX database
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 3.3 feet AGL Gain: 3.0 dBd

Received power (at remote)

> -108.0 dBmW
-118.0 to -108.0 dBmW
< -118.0 dBmW

Minimum threshold level: -150.0 dBmW

Site		Ant Elv AMSL (feet)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
WTC	*	1359.8	18.81	OM-V	N 40 42 43.00
grp: 2		850.0000 MHz			W 74 0 49.00

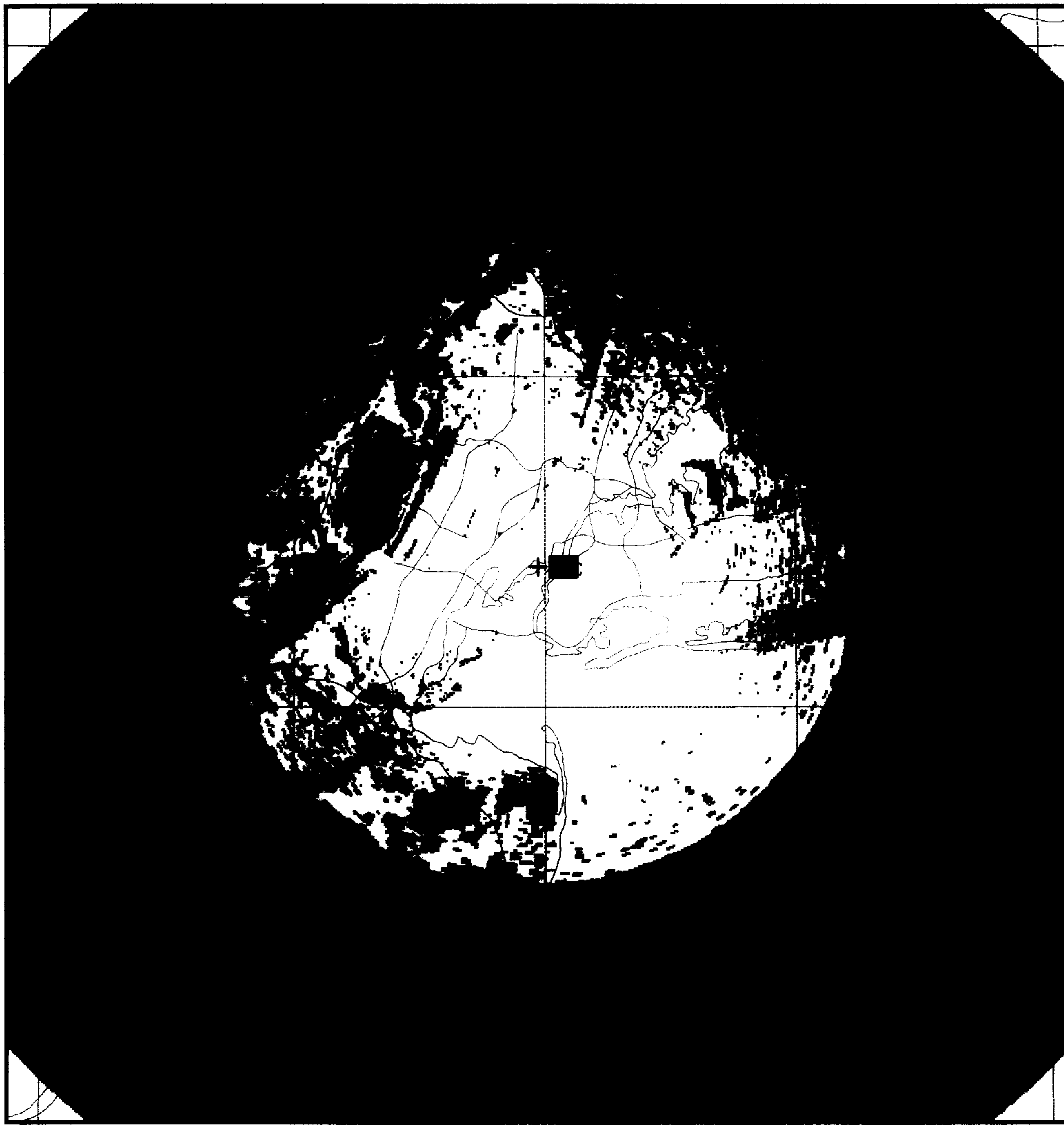
MILES
10 0 10 20 30

NYC SIMULATION

850 MHz

18 September 1996 MO Talk-Out

EXHIBIT-3



SIGNAL (tm):

Propagation model: Hata-extended/E-P diff
Time: 99.00% Loc: 97.00% Margin: 11.5 dB
Climate: Continental Temperate
Gndcvr: USGS-EDX database
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 3.3 feet AGL Gain: 6.0 dBd

Received power (at remote)

> -108.0 dBmW
-118.0 to -108.0 dBmW
< -118.0 dBmW

Minimum threshold level: -150.0 dBmW

Site	Ant Elv AMSL (feet)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
WTC *	1359.8	22.34	OM-V	N 40 42 43.00
grp: 2	1500.0000 MHz			W 74 0 49.00

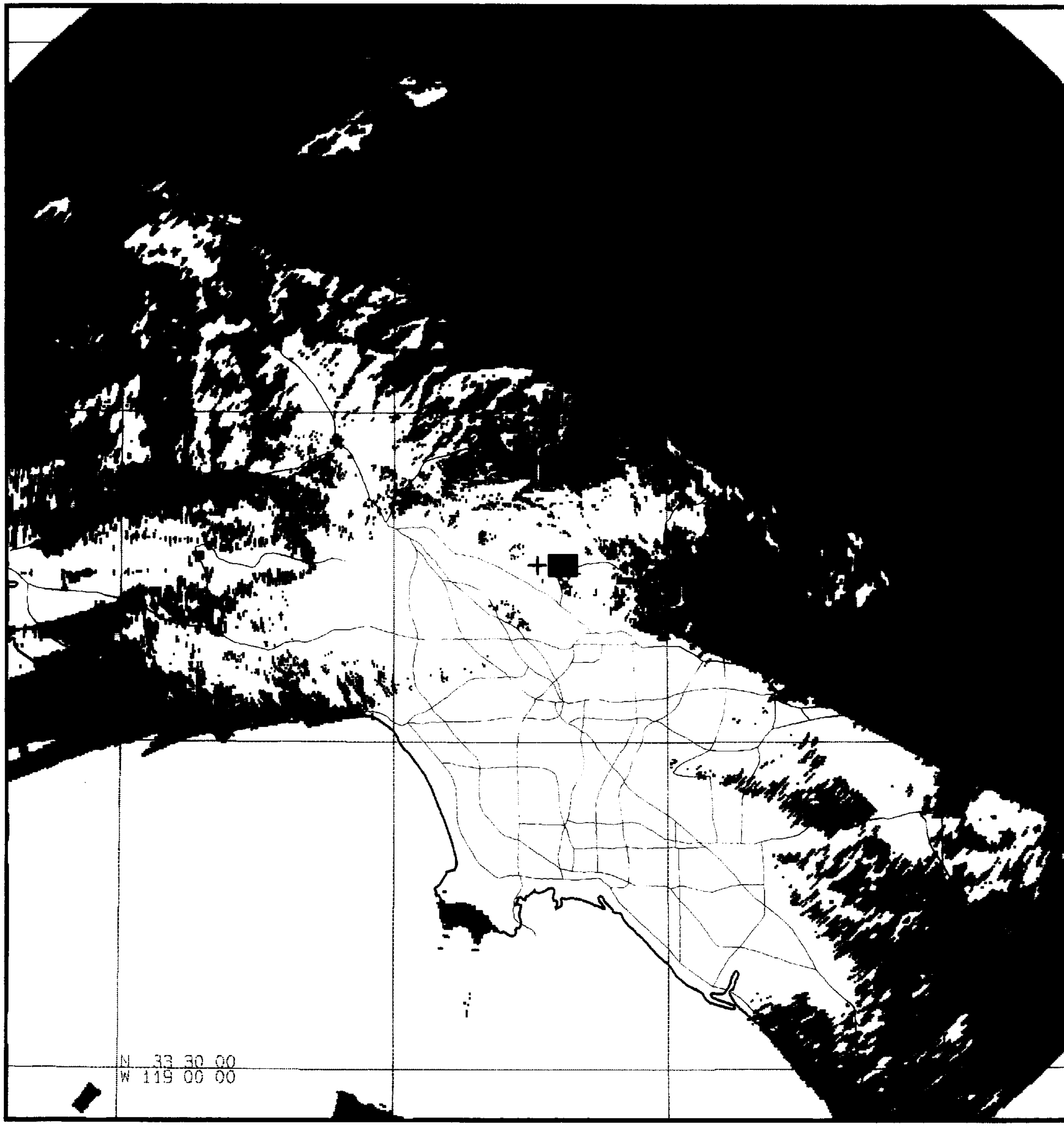
MILES
10 0 10 20 30

NYC SIMULATION

1500 MHz

18 September 1996 MO Talk-Out

EXHIBIT-4



SIGNAL (tm):

Propagation model: Hata-extended/E-P diff
Time: 99.00% Loc: 97.00% Margin: 11.5 dB
Climate: Continental Temperate
Gndcvr: USGS-EDX database
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 3.3 feet AGL Gain: .0 dBd

Received power (at remote)

> -108.0 dBmW
-118.0 to -108.0 dBmW
< -118.0 dBmW

Minimum threshold level: -150.0 dBmW

Site	Ant Elv AMSL (feet)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
MTL *	5144.2	20.00	OM-V	N 34 16 7.00
grp: 2	160.0000 MHz			W118 14 12.00

MILES

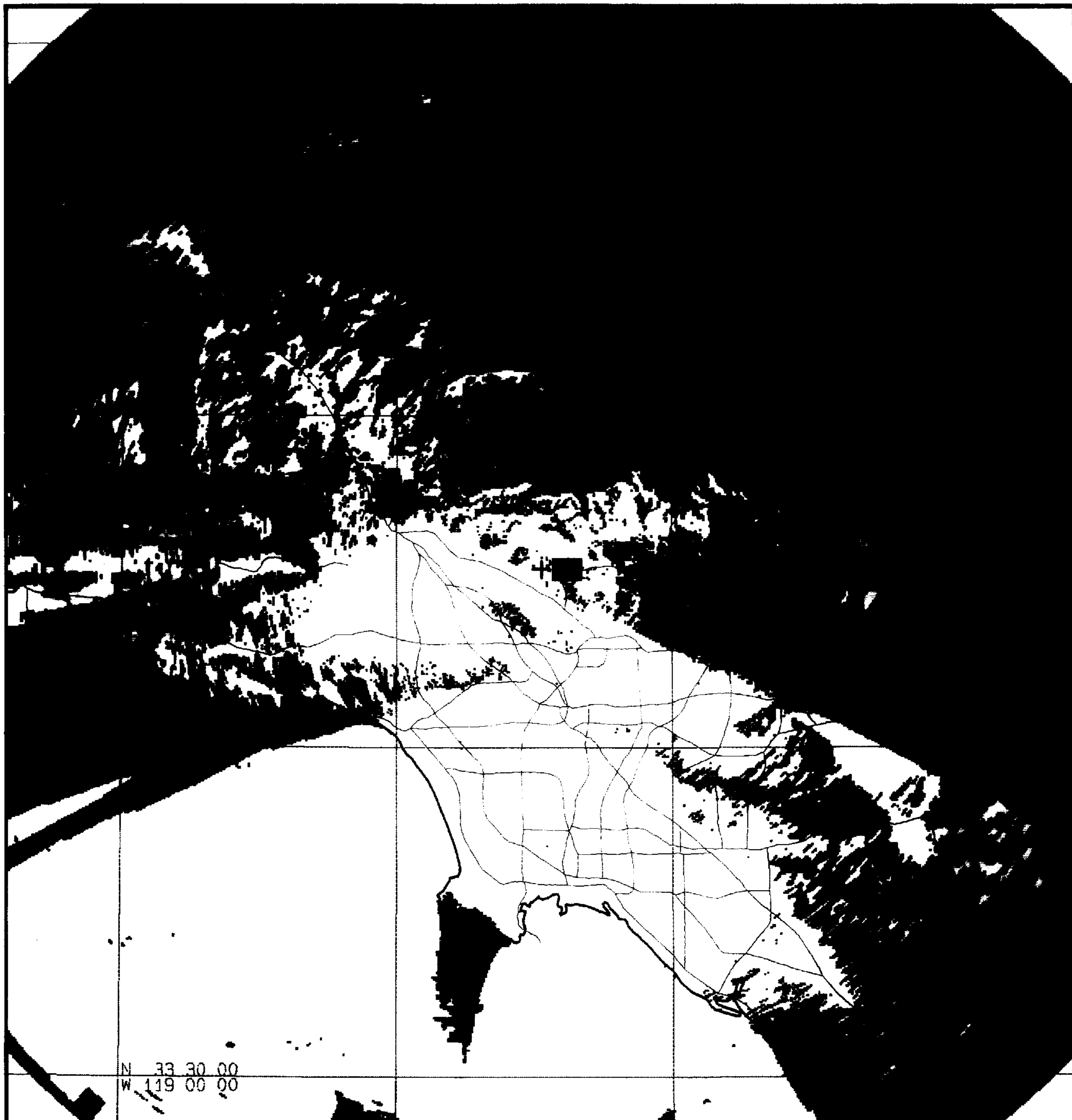
10 0 10 20 30

LOS ANGELES SIMULATION

VHF 160 MHz

18 September 1996 MO Talk-Out

EXHIBIT-5



SIGNAL (tm):

Propagation model: Hata-extended/E-P diff
Time: 99.00% Loc: 97.00% Margin: 11.5 dB
Climate: Continental Temperate
Gndcvr: USGS-EDX database
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 3.3 feet AGL Gain: .0 dBd

Received power (at remote)

> -108.0 dBmW
-118.0 to -108.0 dBmW
< -118.0 dBmW

Minimum threshold level: -150.0 dBmW

Site	Ant Elv AMSL (feet)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
MTL *	5144.2	23.69	OM-V	N 34 16 7.00
grp: 2	406.0000 MHz			W118 14 12.00

MILES

10 0 10 20 30

LOS ANGELES SIMULATION

UHF 406 MHz

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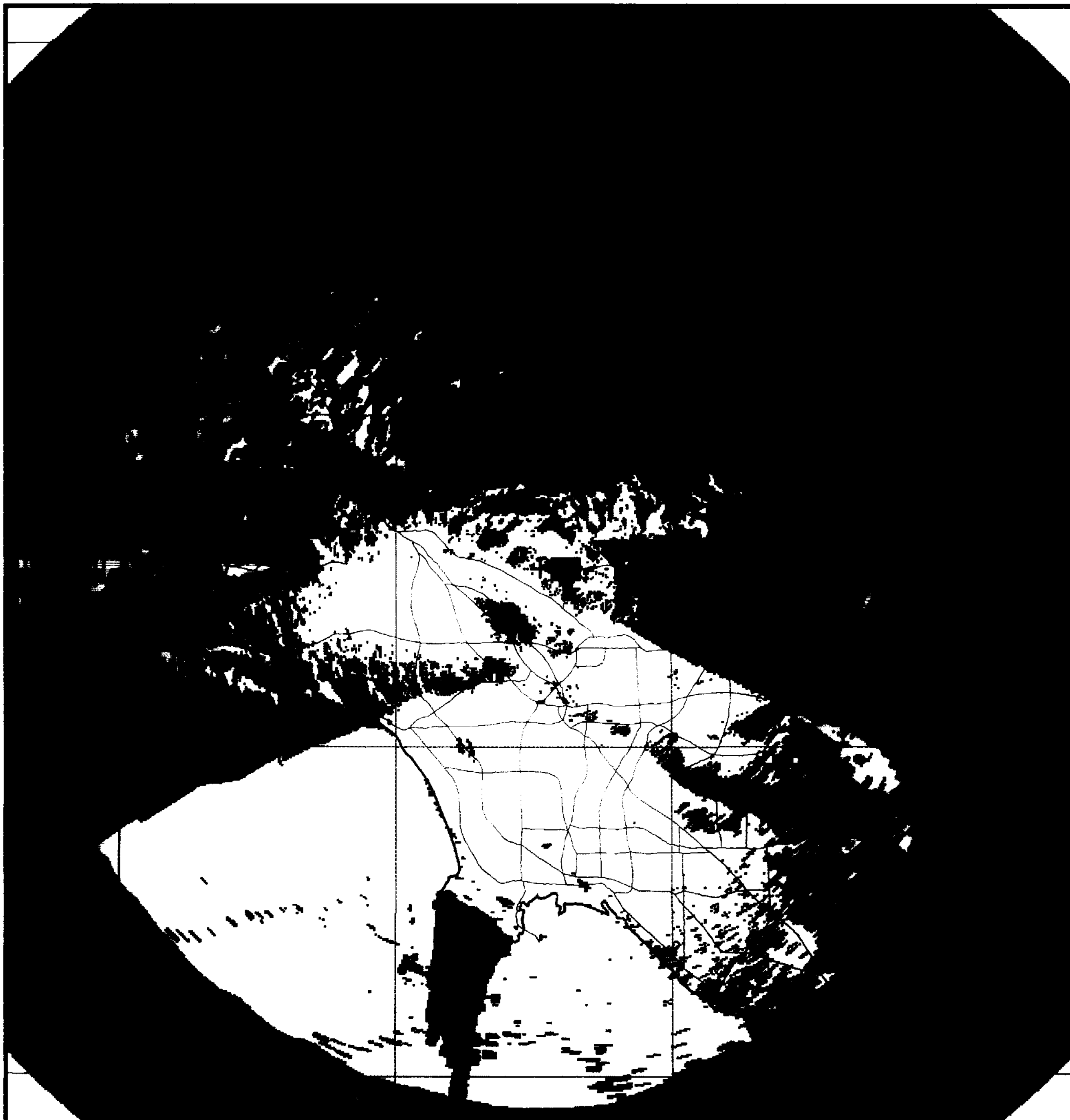
EXHIBIT-6



SIGNAL (tm):

Propagation model: Hata-extended/E-P diff
Time: 99.00% Loc: 97.00% Margin: 11.5 dB
Climate: Continental Temperate
Gndcvr: USGS-EDX database
Atm. factor: None
K Factor: 1.333
RX Antenna: Omni
Height: 3.3 feet AGL Gain: 3.0 dBd

Received power (at remote)

> -108.0 dBmW
-118.0 to -108.0 dBmW
< -118.0 dBmW

Minimum threshold level: -150.0 dBmW

Site		Ant Elv AMSL (feet)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
MTL	*	5144.2	18.81	OM-V	N 34 16 7.00
grp: 2		850.0000 MHz			W118 14 12.00

MILES
10 0 10 20 30

LOS ANGELES SIMULATION
850 MHz

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EXHIBIT-7